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# Topic 201: Linux Kernel

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## Rôle du noyau

Le noyau ou *kernel* est la partie du système d'exploitation qui gère les entrées/sorties avec des périphériques. Dans certains cas il est préférable de recompiler le noyau de Linux. La motivation de cette recompilation peut être :

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- la diminution de la taille du noyau,
- la prise en charge de nouveau matériel,
- l'ajout de fonctionnalités,
- l'optimisation du code,
- la correction de bogues,
- le besoin d'une fonctionnalité expérimentale.

Commencez par mettre à jour CentOS 8 :

```
[root@centos8 ~]# dnf update
...
[root@centos8 ~]# reboot
```

Identifiez ensuite le noyau utilisé par votre machine virtuelle :

```
[root@centos8 ~]# uname -r
4.18.0-305.7.1.el8_4.x86_64
```

## LAB #1 - Modules

Dans le cas d'une utilisation courante de Linux, il est cependant préférable de faire appel aux **modules**. Les modules se trouvent dans le répertoire **/lib/modules/<version-du-noyau>** :

```
[root@centos8 ~]# ls /lib/modules/`uname -r`/
bls.conf          modules.builtin    modules.networking  System.map
build             modules.builtin.bin  modules.order        updates
config           modules.dep        modules.softdep     vdso
kernel           modules.dep.bin    modules.symbols     vmlinuz
modules.alias    modules.devname    modules.symbols.bin  weak-updates
modules.alias.bin  modules.drm        source
modules.block    modules.modesetting  symvers.gz
```

Les commandes pour manipuler les modules sont :

- insmod
- rmmod
- lsmod
- modprobe

Par exemple :

```
[root@centos8 ~]# lsmod
Module                Size  Used by
xt_CHECKSUM           16384  1
ipt_MASQUERADE        16384  3
xt_conntrack          16384  1
ipt_REJECT            16384  2
nft_compat            20480  16
nf_nat_tftp           16384  0
nft_objref            16384  1
nf_conntrack_tftp     16384  3 nf_nat_tftp
nft_counter           16384  33
tun                   53248  1
bridge                192512 0
stp                   16384  1 bridge
llc                   16384  2 bridge,stp
nft_fib_inet          16384  1
nft_fib_ipv4          16384  1 nft_fib_inet
nft_fib_ipv6          16384  1 nft_fib_inet
nft_fib               16384  3 nft_fib_ipv6,nft_fib_ipv4,nft_fib_inet
nft_reject_inet       16384  5
nf_reject_ipv4        16384  2 nft_reject_inet,ipt_REJECT
nf_reject_ipv6        16384  1 nft_reject_inet
nft_reject            16384  1 nft_reject_inet
nft_ct                20480  19
nf_tables_set         49152  21
```

```

nft_chain_nat      16384 12
nf_nat            45056 3 ipt_MASQUERADE,nf_nat_tftp,nft_chain_nat
nf_conntrack     172032 6 xt_conntrack,nf_nat,nf_conntrack_tftp,nft_ct,ipt_MASQUERADE,nf_nat_tftp
nf_defrag_ipv6   20480 1 nf_conntrack
nf_defrag_ipv4   16384 1 nf_conntrack
ip_set           49152 0
nf_tables        172032 414
nft_ct,nft_compat,nft_reject_inet,nft_fib_ipv6,nft_objref,nft_fib_ipv4,nft_counter,nft_chain_nat,nf_tables_set,nft_reject,nft_fib,nft_fib_inet
nfnetlink        16384 4 nft_compat,nf_tables,ip_set
sunrpc           540672 1
ext4             761856 1
mbcache         16384 1 ext4
jbd2            131072 1 ext4
virtio_balloon   20480 0
pcspkr          16384 0
i2c_piix4       24576 0
joydev          24576 0
ip_tables       28672 0
xfs             1515520 1
libcrc32c       16384 4 nf_conntrack,nf_nat,nf_tables,xfs
sr_mod          28672 0
sd_mod          53248 3
cdrom           65536 1 sr_mod
t10_pi         16384 1 sd_mod
sg              40960 0
ata_generic     16384 0
bochs_drm       16384 1
drm_vram_helper 28672 1 bochs_drm
drm_kms_helper  233472 4 drm_vram_helper,bochs_drm
syscopyarea     16384 1 drm_kms_helper
sysfillrect     16384 1 drm_kms_helper
sysimgblt      16384 1 drm_kms_helper
fb_sys_fops     16384 1 drm_kms_helper

```

```
drm_ttm_helper      16384  1 drm_vram_helper
ttm                 114688  2 drm_vram_helper,drm_ttm_helper
drm                 569344  7 drm_kms_helper,drm_vram_helper,bochs_drm,drm_ttm_helper,ttm
ahci                40960  2
libahci            40960  1 ahci
virtio_net         53248  0
net_failover       24576  1 virtio_net
ata_piix           36864  0
serio_raw          16384  0
failover           16384  1 net_failover
libata             270336  4 ata_piix,libahci,ahci,ata_generic
dm_mirror          28672  0
dm_region_hash     20480  1 dm_mirror
dm_log             20480  2 dm_region_hash,dm_mirror
dm_mod             151552  8 dm_log,dm_mirror
fuse               151552  3
```

Pour ajouter un module, on peut utiliser la commande **insmod** ou **modprobe**. Cette dernière ajoute non seulement le module passé en argument mais également ses dépendances :

```
[root@centos8 ~]# modprobe bonding
[root@centos8 ~]# lsmod | more
Module                Size  Used by
bonding               196608  0
xt_CHECKSUM           16384  1
ipt_MASQUERADE        16384  3
xt_conntrack          16384  1
ipt_REJECT            16384  2
nft_compat            20480  16
nf_nat_tftp           16384  0
nft_objref            16384  1
nf_conntrack_tftp     16384  3 nf_nat_tftp
nft_counter           16384  33
tun                   53248  1
```

```
bridge          192512  0
stp             16384  1 bridge
llc            16384  2 bridge,stp
nft_fib_inet    16384  1
nft_fib_ipv4    16384  1 nft_fib_inet
nft_fib_ipv6    16384  1 nft_fib_inet
nft_fib         16384  3 nft_fib_ipv6,nft_fib_ipv4,nft_fib_inet
nft_reject_inet 16384  5
nf_reject_ipv4  16384  2 nft_reject_inet,ipt_REJECT
nf_reject_ipv6  16384  1 nft_reject_inet
--More--
```

Pour supprimer un module, on peut utiliser la commande **rmmod** ou **modprobe -r**. Cette dernière essaie de supprimer les dépendances non-utilisées :

```
[root@centos8 ~]# modprobe -r bonding
[root@centos8 ~]# lsmod | more
Module          Size Used by
xt_CHECKSUM     16384  1
ipt_MASQUERADE  16384  3
xt_contrack    16384  1
ipt_REJECT     16384  2
nft_compat     20480  16
nf_nat_tftp    16384  0
nft_objref     16384  1
nf_contrack_tftp 16384  3 nf_nat_tftp
nft_counter    16384  33
tun            53248  1
bridge        192512  0
stp           16384  1 bridge
llc           16384  2 bridge,stp
nft_fib_inet  16384  1
nft_fib_ipv4  16384  1 nft_fib_inet
nft_fib_ipv6  16384  1 nft_fib_inet
nft_fib       16384  3 nft_fib_ipv6,nft_fib_ipv4,nft_fib_inet
```

```
nft_reject_inet      16384  5
nf_reject_ipv4      16384  2 nft_reject_inet,ipt_REJECT
nf_reject_ipv6      16384  1 nft_reject_inet
nft_reject           16384  1 nft_reject_inet
--More--
```

Les dépendances des modules sont résolues par la commande **modprobe** grâce aux fichier **/lib/modules/<version-du-noyau>/modules.dep**. Ce dernier peut être créé manuellement grâce à la commande **depmod** :

```
[root@centos8 ~]# more /lib/modules/`uname -r`/modules.dep
kernel/arch/x86/events/amd/power.ko.xz:
kernel/arch/x86/events/intel/intel-uncore.ko.xz:
kernel/arch/x86/events/intel/intel-cstate.ko.xz:
kernel/arch/x86/events/rapl.ko.xz:
kernel/arch/x86/kernel/cpu/mce/mce-inject.ko.xz:
kernel/arch/x86/crypto/des3_edc-x86_64.ko.xz: kernel/crypto/des_generic.ko.xz
kernel/arch/x86/crypto/camellia-x86_64.ko.xz:
kernel/arch/x86/crypto/blowfish-x86_64.ko.xz: kernel/crypto/blowfish_common.ko.xz
kernel/arch/x86/crypto/twofish-x86_64.ko.xz: kernel/crypto/twofish_common.ko.xz
kernel/arch/x86/crypto/twofish-x86_64-3way.ko.xz: kernel/arch/x86/crypto/twofish-x86_64.ko.
xz kernel/crypto/twofish_common.ko.xz
kernel/arch/x86/crypto/chacha20-x86_64.ko.xz: kernel/crypto/chacha20_generic.ko.xz
kernel/arch/x86/crypto/serpent-sse2-x86_64.ko.xz: kernel/crypto/serpent_generic.ko.xz
kernel/arch/x86/crypto/ghash-clmulni-intel.ko.xz:
kernel/arch/x86/crypto/crc32c-intel.ko.xz:
kernel/arch/x86/crypto/crc32-pclmul.ko.xz:
kernel/arch/x86/crypto/sha512-ssse3.ko.xz: kernel/crypto/sha512_generic.ko.xz
kernel/arch/x86/crypto/crct10dif-pclmul.ko.xz:
kernel/arch/x86/crypto/poly1305-x86_64.ko.xz: kernel/crypto/poly1305_generic.ko.xz
kernel/arch/x86/crypto/camellia-aesni-avx-x86_64.ko.xz: kernel/arch/x86/crypto/camellia-x86
_64.ko.xz
kernel/arch/x86/crypto/cast5-avx-x86_64.ko.xz: kernel/crypto/cast5_generic.ko.xz kernel/cry
--More-- (0%)
```

Il est possible d'obtenir des informations sur un module grâce à la commande **modinfo** :

```
[root@centos8 ~]# modinfo bonding
filename:      /lib/modules/4.18.0-305.7.1.el8_4.x86_64/kernel/drivers/net/bonding/bonding.ko.xz
author:       Thomas Davis, tadavis@lbl.gov and many others
description:  Ethernet Channel Bonding Driver
license:      GPL
alias:        rtnl-link-bond
rhelversion:  8.4
srcversion:   445F4CC9A2F7E64E3A87FD0
depends:
intree:       Y
name:         bonding
vermagic:     4.18.0-305.7.1.el8_4.x86_64 SMP mod_unload modversions
sig_id:       PKCS#7
signer:       CentOS kernel signing key
sig_key:      3B:5A:0A:B8:8E:4A:51:C0:AA:FF:97:FD:CB:94:D6:B6:D2:46:B8:17
sig_hashalgo: sha256
signature:    B2:3A:20:BE:2B:F3:E0:5A:1A:74:0E:69:76:40:2A:D4:80:10:2C:5A:
              B7:F1:1E:7A:71:13:29:F0:0A:4A:28:EE:81:33:C8:C2:5C:BD:FF:E4:
              3F:A9:15:A3:9A:0E:A7:98:9E:99:06:23:10:47:D3:B2:48:B3:F1:61:
              BE:4B:B0:FC:62:B9:3B:D6:64:CC:E3:29:01:4D:91:92:32:FD:EB:54:
              44:F1:2C:1B:23:30:F1:3E:EE:69:EA:94:54:D9:A0:8D:16:53:F5:20:
              DE:38:A0:13:E8:2F:89:66:CB:11:D7:AA:30:37:7B:EC:DF:A1:69:29:
              7F:4E:80:4D:34:6E:F2:07:01:FA:18:23:94:58:10:C6:97:27:68:B9:
              D8:08:5E:9D:00:17:F4:1B:48:BE:CA:BF:5C:5A:A8:6D:36:EE:3F:95:
              BA:BE:59:82:EE:7B:CA:BB:32:1E:E3:05:ED:C9:C2:C8:10:64:B9:29:
              B8:09:4B:79:42:65:1A:FA:99:96:BA:7E:2D:6E:75:F1:91:0E:F4:9A:
              8F:11:10:9F:70:BD:35:06:BE:F0:4C:D8:AB:D5:C4:E1:B3:A2:2A:CA:
              58:CA:9E:16:1D:0C:BE:9C:37:A1:82:20:6F:24:CD:23:63:F7:F5:BC:
              6E:81:14:F0:52:DA:04:0E:9D:CC:17:60:2D:B0:D8:BD:6E:2C:AD:E7:
              50:48:49:B6:57:96:AC:FD:A4:29:33:01:43:92:32:88:A2:AC:CB:93:
              2F:C3:29:F3:01:77:84:00:AB:AA:C8:59:43:F1:DA:90:7B:5F:9A:A9:
              CA:60:97:34:85:5E:98:56:73:03:0D:D7:8D:A6:AB:51:D4:8C:92:91:
```

```
0C:0A:BA:6B:92:01:16:FE:8B:86:80:11:5F:8E:21:BD:C2:2F:02:58:
A6:CF:6C:E3:87:28:8B:4D:CE:54:8C:00:B3:F7:AE:9E:01:81:1E:83:
AE:6D:58:B0:10:98:36:D9:69:76:E2:C0:E2:15:94:3B:D4:14:19:D9:
59:86:75:31
parm:      max_bonds:Max number of bonded devices (int)
parm:      tx_queues:Max number of transmit queues (default = 16) (int)
parm:      num_grat_arp:Number of peer notifications to send on failover event (alias of num_unsol_na) (int)
parm:      num_unsol_na:Number of peer notifications to send on failover event (alias of num_grat_arp) (int)
parm:      miimon:Link check interval in milliseconds (int)
parm:      updelay:Delay before considering link up, in milliseconds (int)
parm:      downdelay:Delay before considering link down, in milliseconds (int)
parm:      use_carrier:Use netif_carrier_ok (vs MII ioctls) in miimon; 0 for off, 1 for on (default) (int)
parm:      mode:Mode of operation; 0 for balance-rr, 1 for active-backup, 2 for balance-xor, 3 for
broadcast, 4 for 802.3ad, 5 for balance-tlb, 6 for balance-alb (charp)
parm:      primary:Primary network device to use (charp)
parm:      primary_reselect:Reselect primary slave once it comes up; 0 for always (default), 1 for only if
speed of primary is better, 2 for only on active slave failure (charp)
parm:      lacp_rate:LACPDU tx rate to request from 802.3ad partner; 0 for slow, 1 for fast (charp)
parm:      ad_select:802.3ad aggregation selection logic; 0 for stable (default), 1 for bandwidth, 2 for
count (charp)
parm:      min_links:Minimum number of available links before turning on carrier (int)
parm:      xmit_hash_policy:balance-alb, balance-tlb, balance-xor, 802.3ad hashing method; 0 for layer 2
(default), 1 for layer 3+4, 2 for layer 2+3, 3 for encap layer 2+3, 4 for encap layer 3+4, 5 for vlan+srcmac
(charp)
parm:      arp_interval:arp interval in milliseconds (int)
parm:      arp_ip_target:arp targets in n.n.n.n form (array of charp)
parm:      arp_validate:validate src/dst of ARP probes; 0 for none (default), 1 for active, 2 for backup, 3
for all (charp)
parm:      arp_all_targets:fail on any/all arp targets timeout; 0 for any (default), 1 for all (charp)
parm:      fail_over_mac:For active-backup, do not set all slaves to the same MAC; 0 for none (default), 1
for active, 2 for follow (charp)
parm:      all_slaves_active:Keep all frames received on an interface by setting active flag for all slaves;
0 for never (default), 1 for always. (int)
parm:      resend_igmp:Number of IGMP membership reports to send on link failure (int)
```

```
parm:          packets_per_slave:Packets to send per slave in balance-rr mode; 0 for a random slave, 1 packet
per slave (default), >1 packets per slave. (int)
parm:          lp_interval:The number of seconds between instances where the bonding driver sends learning
packets to each slaves peer switch. The default is 1. (uint)
```

Dernièrement, les fichiers dans le repertoire **/etc/modprobe.d** sont utilisés pour spécifier les options éventuelles à passer aux modules lors de leur chargement ainsi que les alias utilisés pour leur faire référence :

```
[root@centos8 ~]# ls /etc/modprobe.d
firewalld-sysctls.conf  lockd.conf  nvdimm-security.conf  tuned.conf
kvm.conf                mlx4.conf  truescale.conf        vhost.conf

[root@centos8 ~]# cat /etc/modprobe.d/kvm.conf
# Setting modprobe kvm_intel/kvm_amd nested = 1
# only enables Nested Virtualization until the next reboot or
# module reload. Uncomment the option applicable
# to your system below to enable the feature permanently.
#
# User changes in this file are preserved across upgrades.
#
# For Intel
#options kvm_intel nested=1
#
# For AMD
#options kvm_amd nested=1
```

## LAB #2 - Compilation et installation du noyau et des modules sous CentOS 8

Activez le dépôt **CentOS-Linux-PowerTools** en passant la directive **enabled** à **1** :

```
[root@centos8 ~]# vi /etc/yum.repos.d/CentOS-Linux-PowerTools.repo
[root@centos8 ~]# cat /etc/yum.repos.d/CentOS-Linux-PowerTools.repo
```

```
# CentOS-Linux-PowerTools.repo
#
# The mirrorlist system uses the connecting IP address of the client and the
# update status of each mirror to pick current mirrors that are geographically
# close to the client. You should use this for CentOS updates unless you are
# manually picking other mirrors.
#
# If the mirrorlist does not work for you, you can try the commented out
# baseurl line instead.

[powertools]
name=CentOS Linux $releasever - PowerTools
mirrorlist=http://mirrorlist.centos.org/?release=$releasever&arch=$basearch&repo=PowerTools&infra=$infra
#baseurl=http://mirror.centos.org/$contentdir/$releasever/PowerTools/$basearch/os/
gpgcheck=1
enabled=1
gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-centosofficial
```

Installez maintenant les paquets nécessaires :

```
[root@centos8 ~]# dnf groupinstall "Development Tools"
...
[root@centos8 ~]# dnf install asciidoc audit-libs-devel bash bc binutils binutils-devel bison diffutils elfutils
elfutils-devel elfutils-libelf-devel findutils flex gawk gcc gettext gzip htmldoc hostname make module-init-
tools ncurses-devel net-tools newt-devel numactl-devel openssl patch pciutils-devel perl perl-ExtUtils-Embed
pesign redhat-rpm-config rpm-build rpmdevtools sh-utils tar xmlto xz zlib-devel
...
```

## 2.1 - Déplacer /home



**Important** - Il n'est pas conseillé de compiler en tant que root pour des raisons de sécurité. Pour pouvoir utiliser le compte d'un utilisateur pour créer un nouveau noyau,



celui-ci doit disposer de plus de 10 Go d'espace libre.



**A faire - Déconnectez-vous** de votre session **CentOS8\_SSH\_10.0.2.45** et re-connectez-vous à la VM en tant que root en utilisant la connexion **CentOS8\_ROOT\_10.0.2.45**.

Créez ensuite une seule partition sur **/dev/sdc** :

```
[root@centos8 ~]# fdisk /dev/sdc

Welcome to fdisk (util-linux 2.32.1).
Changes will remain in memory only, until you decide to write them.
Be careful before using the write command.

Device does not contain a recognized partition table.
Created a new DOS disklabel with disk identifier 0xc321702b.

Command (m for help): n
Partition type
   p   primary (0 primary, 0 extended, 4 free)
   e   extended (container for logical partitions)
Select (default p):

Using default response p.
Partition number (1-4, default 1):
First sector (2048-41943039, default 2048):
Last sector, +sectors or +size{K,M,G,T,P} (2048-41943039, default 41943039):

Created a new partition 1 of type 'Linux' and of size 20 GiB.

Command (m for help): w
```

```
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.
```

Créez maintenant un système de fichiers ext4 sur **/dev/sdc1** :

```
[root@centos8 ~]# mkfs.ext4 /dev/sdc1  
mke2fs 1.45.6 (20-Mar-2020)  
Discarding device blocks: done  
Creating filesystem with 16776960 4k blocks and 4194304 inodes  
Filesystem UUID: dc92c0d7-919b-4fff-8719-53e9e7e628dd  
Superblock backups stored on blocks:  
    32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,  
    4096000, 7962624, 11239424  
  
Allocating group tables: done  
Writing inode tables: done  
Creating journal (65536 blocks): done  
Writing superblocks and filesystem accounting information: done
```

Montez **/dev/sdc1** sur /mnt :

```
[root@centos8 ~]# mount /dev/sdc1 /mnt
```

Copiez le contenu de /home vers /mnt :

```
[root@centos8 ~]# cp -a /home/* /mnt
```

Démontez /dev/sdc1 et déplacez /home vers /root :

```
[root@centos8 ~]# umount /mnt  
[root@centos8 ~]# mv /home /root
```

Identifiez l'UUID de /dev/sdc1 :

```
[root@centos8 ~]# ls -l /dev/disk/by-uuid/ | grep sdc1
lrwxrwxrwx. 1 root root 10 Jul 19 12:02 f76d6b66-985b-4a91-af9c-4987e8c1443c -> ../../sdc
[root@centos8 ~]#
```

Editez le fichier **/etc/fstab** et ajoutez une ligne pour /dev/sdc1 :

```
[root@centos8 ~]# vi /etc/fstab
[root@centos8 ~]# cat /etc/fstab

#
# /etc/fstab
# Created by anaconda on Wed Jun 16 06:21:32 2021
#
# Accessible filesystems, by reference, are maintained under '/dev/disk/'.
# See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for more info.
#
# After editing this file, run 'systemctl daemon-reload' to update systemd
# units generated from this file.
#
/dev/mapper/cl_centos8-root / xfs defaults 0 0
UUID=1c04981e-5317-4b73-9695-3ce25246835d /boot ext4 defaults 1 2
/dev/mapper/cl_centos8-swap swap swap defaults 0 0
UUID=f76d6b66-985b-4a91-af9c-4987e8c1443c /home ext4 defaults 1 2
```

Créez le point de montage /home :

```
[root@centos8 ~]# mkdir /home
```

Montez /dev/sdc1 :

```
[root@centos8 ~]# mount -a
[root@centos8 ~]# mount
```

```
sysfs on /sys type sysfs (rw,nosuid,nodev,noexec,relatime,seclabel)
proc on /proc type proc (rw,nosuid,nodev,noexec,relatime)
devtmpfs on /dev type devtmpfs (rw,nosuid,seclabel,size=1882880k,nr_inodes=470720,mode=755)
securityfs on /sys/kernel/security type securityfs (rw,nosuid,nodev,noexec,relatime)
tmpfs on /dev/shm type tmpfs (rw,nosuid,nodev,seclabel)
devpts on /dev/pts type devpts (rw,nosuid,noexec,relatime,seclabel,gid=5,mode=620,ptmxmode=000)
tmpfs on /run type tmpfs (rw,nosuid,nodev,seclabel,mode=755)
tmpfs on /sys/fs/cgroup type tmpfs (ro,nosuid,nodev,noexec,seclabel,mode=755)
cgroup on /sys/fs/cgroup/systemd type cgroup
(rw,nosuid,nodev,noexec,relatime,seclabel,xattr,release_agent=/usr/lib/systemd/systemd-cgroups-
agent,name=systemd)
pstore on /sys/fs/pstore type pstore (rw,nosuid,nodev,noexec,relatime,seclabel)
bpf on /sys/fs/bpf type bpf (rw,nosuid,nodev,noexec,relatime,mode=700)
cgroup on /sys/fs/cgroup/hugetlb type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,hugetlb)
cgroup on /sys/fs/cgroup/memory type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,memory)
cgroup on /sys/fs/cgroup/cpu,cpuacct type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,cpu,cpuacct)
cgroup on /sys/fs/cgroup/rdma type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,rdma)
cgroup on /sys/fs/cgroup/pids type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,pids)
cgroup on /sys/fs/cgroup/cpuset type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,cpuset)
cgroup on /sys/fs/cgroup/perf_event type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,perf_event)
cgroup on /sys/fs/cgroup/freezer type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,freezer)
cgroup on /sys/fs/cgroup/blkio type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,blkio)
cgroup on /sys/fs/cgroup/net_cls,net_prio type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,net_cls,net_prio)
cgroup on /sys/fs/cgroup/devices type cgroup (rw,nosuid,nodev,noexec,relatime,seclabel,devices)
none on /sys/kernel/tracing type tracefs (rw,relatime,seclabel)
configfs on /sys/kernel/config type configfs (rw,relatime)
/dev/mapper/cl_centos8-root on / type xfs (rw,relatime,seclabel,attr2,inode64,logbufs=8,logbsize=32k,noquota)
selinuxfs on /sys/fs/selinux type selinuxfs (rw,relatime)
mqueue on /dev/mqueue type mqueue (rw,relatime,seclabel)
hugetlbfs on /dev/hugepages type hugetlbfs (rw,relatime,seclabel,pagesize=2M)
debugfs on /sys/kernel/debug type debugfs (rw,relatime,seclabel)
systemd-1 on /proc/sys/fs/binfmt_misc type autofs
(rw,relatime,fd=40,pgrp=1,timeout=0,minproto=5,maxproto=5,direct,pipe_ino=6022)
fusectl on /sys/fs/fuse/connections type fusectl (rw,relatime)
```

```
/dev/sda1 on /boot type ext4 (rw,relatime,seclabel)
sunrpc on /var/lib/nfs/rpc_pipefs type rpc_pipefs (rw,relatime)
tmpfs on /run/user/1000 type tmpfs (rw,nosuid,nodev,relatime,seclabel,size=382500k,mode=700,uid=1000,gid=1000)
tmpfs on /run/user/42 type tmpfs (rw,nosuid,nodev,relatime,seclabel,size=382500k,mode=700,uid=42,gid=42)
gvfsd-fuse on /run/user/1000/gvfs type fuse.gvfsd-fuse (rw,nosuid,nodev,relatime,user_id=1000,group_id=1000)
tmpfs on /run/user/0 type tmpfs (rw,nosuid,nodev,relatime,seclabel,size=382500k,mode=700)
gvfsd-fuse on /run/user/0/gvfs type fuse.gvfsd-fuse (rw,nosuid,nodev,relatime,user_id=0,group_id=0)
/dev/sdc1 on /home type ext4 (rw,relatime,seclabel)
```

Notez la taille de /home :

```
[root@centos8 ~]# df -h
Filesystem                Size      Used Avail Use% Mounted on
devtmpfs                  1.8G         0  1.8G   0% /dev
tmpfs                     1.9G         0  1.9G   0% /dev/shm
tmpfs                     1.9G     9.4M  1.9G   1% /run
tmpfs                     1.9G         0  1.9G   0% /sys/fs/cgroup
/dev/mapper/cl_centos8-root 28G     5.2G   23G  19% /
/dev/sda1                 976M     289M  620M  32% /boot
tmpfs                     374M      16K   374M   1% /run/user/1000
tmpfs                     374M     1.2M   373M   1% /run/user/42
/dev/sdc1                  63G       67M   60G   1% /home
```



**A faire - Déconnectez-vous** de votre session **CentOS8\_ROOT\_10.0.2.45** et re-connectez-vous à la VM en tant que trainee en utilisant la connexion **CentOS8\_SSH\_10.0.2.45**.

## 2.2 - Préparer l'Environnement

Pour créer l'arborescence de l'environnement de création de paquets dans /home/trainee, utilisez la commande **rpmdev-setuptree** :

```
[trainee@centos8 ~]$ rpmdev-setuptree
...>
[trainee@centos8 ~]$ ls -laR rpmbuild/
rpmbuild/:
total 28
drwxrwxr-x.  7 trainee trainee 4096 Jul 19 12:10 .
drwxr-xr-x. 17 trainee trainee 4096 Jul 19 12:10 ..
drwxrwxr-x.  2 trainee trainee 4096 Jul 19 12:10 BUILD
drwxrwxr-x.  2 trainee trainee 4096 Jul 19 12:10 RPMS
drwxrwxr-x.  2 trainee trainee 4096 Jul 19 12:10 SOURCES
drwxrwxr-x.  2 trainee trainee 4096 Jul 19 12:10 SPECS
drwxrwxr-x.  2 trainee trainee 4096 Jul 19 12:10 SRPMS

rpmbuild/BUILD:
total 8
drwxrwxr-x. 2 trainee trainee 4096 Jul 19 12:10 .
drwxrwxr-x. 7 trainee trainee 4096 Jul 19 12:10 ..

rpmbuild/RPMS:
total 8
drwxrwxr-x. 2 trainee trainee 4096 Jul 19 12:10 .
drwxrwxr-x. 7 trainee trainee 4096 Jul 19 12:10 ..

rpmbuild/SOURCES:
total 8
drwxrwxr-x. 2 trainee trainee 4096 Jul 19 12:10 .
drwxrwxr-x. 7 trainee trainee 4096 Jul 19 12:10 ..

rpmbuild/SPECS:
total 8
drwxrwxr-x. 2 trainee trainee 4096 Jul 19 12:10 .
drwxrwxr-x. 7 trainee trainee 4096 Jul 19 12:10 ..

rpmbuild/SRPMS:
```

```
total 8
drwxrwxr-x. 2 trainee trainee 4096 Jul 19 12:10 .
drwxrwxr-x. 7 trainee trainee 4096 Jul 19 12:10 ..
```

Téléchargez le rpm source du noyau :

```
[trainee@centos8 ~]$ uname -a
Linux centos8.ittraining.loc 4.18.0-305.7.1.el8_4.x86_64 #1 SMP Tue Jun 29 21:55:12 UTC 2021 x86_64 x86_64 x86_64
GNU/Linux

[trainee@centos8 ~]$ cat /etc/centos-release
CentOS Linux release 8.4.2105

[trainee@centos8 ~]$ wget
https://vault.centos.org/8.4.2105/BaseOS/Source/SPackages/kernel-4.18.0-305.7.1.el8_4.src.rpm
--2021-07-14 02:54:14--
https://vault.centos.org/8.4.2105/BaseOS/Source/SPackages/kernel-4.18.0-305.7.1.el8_4.src.rpm
Resolving vault.centos.org (vault.centos.org)... 81.171.33.194, 2a05:d014:10:7803:4af1:9320:7050:d28e
Connecting to vault.centos.org (vault.centos.org)|81.171.33.194|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 123000617 (117M) [application/x-rpm]
Saving to: 'kernel-4.18.0-305.7.1.el8_4.src.rpm'

kernel-4.18.0-305.7.1. 100%[=====>] 117.30M  1.49MB/s   in 79s

2021-07-14 02:55:33 (1.49 MB/s) - 'kernel-4.18.0-305.7.1.el8_4.src.rpm' saved [123000617/123000617]
```

Installez maintenant les dépendances pour le rpm source en tant que root :

```
[trainee@centos8 ~]$ su -
Mot de passe : fenestros

[root@centos8 ~]# dnf install yum-utils
...
```





```
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
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warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
##### [100%]
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
```

```
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
warning: user mockbuild does not exist - using root
warning: group mockbuild does not exist - using root
```



**Important** - Les erreurs sont sans importance.

## 2.3 - Préparer l'Arborescence Source du Noyau

Naviguez vers le repertoire `~/rpmbuild/SPECS` et utilisez la commande `rpmbuild` pour préparer l'arborescence source du noyau :

```
[trainee@centos7 ~]$ cd ~/rpmbuild/SPECS
[trainee@centos7 SPECS]$ rpmbuild -bp --target=$(uname -m) kernel.spec
...
```

A l'issu du processus, examinez l'arborescence :

```
[trainee@centos8 SPECS]$ ls -la ~/rpmbuild/BUILD/kernel-4.18.0-305.7.1.el8_4/linux-4.18.0-305.7.1.el8.x86_64/
total 812
drwxr-xr-x. 26 trainee trainee 4096 Jul 14 03:13 .
drwxr-xr-x.  3 trainee trainee 4096 Jul 14 03:12 ..
drwxr-xr-x. 27 trainee trainee 4096 Jul 14 03:13 arch
drwxr-xr-x.  3 trainee trainee 4096 Jun 14 10:33 block
drwxr-xr-x.  2 trainee trainee 4096 Jul 14 03:13 certs
-rw-r--r--.  1 trainee trainee 13079 Jun 14 10:33 .clang-format
-rw-r--r--.  1 trainee trainee   59 Jun 14 10:33 .coocciconfig
```

```
drwxr-xr-x.  2 trainee trainee  4096 Jul 14 03:13 configs
-rw-r--r--.  1 trainee trainee    423 Jun 14 10:33 COPYING-4.18.0
-rw-r--r--.  1 trainee trainee 98651 Jun 14 10:33 CREDITS
drwxr-xr-x.  4 trainee trainee  4096 Jun 14 10:33 crypto
drwxr-xr-x. 119 trainee trainee  4096 Jul 14 03:13 Documentation
drwxr-xr-x. 137 trainee trainee  4096 Jun 14 10:33 drivers
drwxr-xr-x.  2 trainee trainee  4096 Jul 14 03:13 firmware
drwxr-xr-x.  73 trainee trainee  4096 Jun 14 10:33 fs
-rw-r--r--.  1 trainee trainee    68 Jun 14 10:33 .get_maintainer.conf
-rw-r--r--.  1 trainee trainee    31 Jun 14 10:33 .get_maintainer.ignore
-rw-r--r--.  1 trainee trainee    76 Jun 14 10:33 .gitattributes
-rw-r--r--.  1 trainee trainee  1639 Jun 14 10:33 .gitlab-ci-private.yml
-rw-r--r--.  1 trainee trainee  1668 Jun 14 10:33 .gitlab-ci.yml
drwxr-xr-x.  30 trainee trainee  4096 Jun 14 10:33 include
drwxr-xr-x.  2 trainee trainee  4096 Jun 14 10:33 init
drwxr-xr-x.  2 trainee trainee  4096 Jun 14 10:33 ipc
-rw-r--r--.  1 trainee trainee  2245 Jun 14 10:33 Kbuild
-rw-r--r--.  1 trainee trainee   575 Jun 14 10:33 Kconfig
drwxr-xr-x.  19 trainee trainee  4096 Jul 14 03:13 kernel
drwxr-xr-x.  20 trainee trainee 12288 Jul 14 03:13 lib
drwxr-xr-x.  5 trainee trainee  4096 Jun 14 10:33 LICENSES
-rw-r--r--.  1 trainee trainee  9559 Jun 14 10:33 .mailmap
-rw-r--r--.  1 trainee trainee 471696 Jun 14 10:33 MAINTAINERS
-rw-r--r--.  1 trainee trainee 61558 Jun 14 10:33 Makefile
-rw-r--r--.  1 trainee trainee  1324 Jun 14 10:33 Makefile.rhelver
-rw-r--r--.  1 trainee trainee     0 Jul 14 03:13 .mismatches
drwxr-xr-x.  3 trainee trainee  4096 Jun 14 10:33 mm
drwxr-xr-x.  72 trainee trainee  4096 Jun 14 10:33 net
-rw-r--r--.  1 trainee trainee   800 Jun 14 10:33 README
drwxr-xr-x.  28 trainee trainee  4096 Jun 14 10:33 samples
-rw-r--r--.  1 trainee trainee     0 Jul 14 03:12 .scmversion
drwxr-xr-x.  14 trainee trainee  4096 Jul 14 03:13 scripts
drwxr-xr-x.  10 trainee trainee  4096 Jun 14 10:33 security
drwxr-xr-x.  26 trainee trainee  4096 Jun 14 10:33 sound
```

```
drwxr-xr-x. 33 trainee trainee 4096 Jun 14 10:33 tools
drwxr-xr-x.  2 trainee trainee 4096 Jul 14 03:13 usr
drwxr-xr-x.  4 trainee trainee 4096 Jun 14 10:33 virt
```

## Le Fichier .config

Changez de répertoire de travail :

```
[trainee@centos8 SPECS]$ cd ~/rpmbuild/BUILD/kernel-*/linux-*/
```

Copiez le fichier **configs/kernel-4.18.0-`uname -m`.config** vers **.config** dans le répertoire courant :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ cp configs/kernel-4.18.0-`uname -m`.config .config
```

Mettez à jour le fichier .config par rapport à la configuration actuelle du noyau :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ make oldconfig
scripts/kconfig/conf --oldconfig Kconfig
#
# configuration written to .config
#
```



**Important** - Cette commande lit le fichier .config du noyau actuel et le compare avec celui des sources du noyau. S'il existe des nouvelles configurations à effectuer dans les sources du noyau, la commande vous pose des questions.

La configuration du noyau se trouve dans un fichier dénommé **.config**. Le fichier **.config** est généré par une des trois commandes suivantes et ne doit **pas** être édité manuellement :

- make config

- make menuconfig
- make xconfig

Exécutez la commande **make menuconfig** :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ make menuconfig
UPD      scripts/kconfig/.mconf-cfg
HOSTCC   scripts/kconfig/mconf.o
HOSTCC   scripts/kconfig/lxdialog/checklist.o
HOSTCC   scripts/kconfig/lxdialog/inputbox.o
HOSTCC   scripts/kconfig/lxdialog/menubox.o
HOSTCC   scripts/kconfig/lxdialog/textbox.o
HOSTCC   scripts/kconfig/lxdialog/util.o
HOSTCC   scripts/kconfig/lxdialog/yesno.o
HOSTLD   scripts/kconfig/mconf
scripts/kconfig/mconf  Kconfig
#
# using defaults found in /boot/config-4.18.0-305.7.1.el8_4.x86_64
#
```

Dans l'interface, vous pouvez constater la présence de lignes correspondantes à des fonctionnalités suivies par une lettre ou une valeur. Dans le cas d'une lettre, la signification est la suivante :

- **y**,
  - la fonctionnalité est incluse dans le noyau monolithique ou dans le cas d'une dépendance d'un module, dans le module concerné,
- **m**,
  - la fonctionnalité est incluse en tant que module,
- **n**,
  - la fonctionnalité n'est pas incluse.



**Important** - Cette commande permet la modification de la configuration du noyau.

Sauvegardez simplement la configuration actuelle et sortez de l'interface :

```
*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.
```

Vérifiez que le fichier **.config** a été créé par l'exécution de makeconfig :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ ls -a
.      certs          configs      Documentation  .get_maintainer.conf  .gitlab-ci.yml  Kbuild  LICENSES
Makefile.rhelfer  README      security    virt
..     .clang-format  COPYING-4.18.0  drivers      .get_maintainer.ignore  include        Kconfig  .mailmap
.mismatches      samples     sound
arch  .coocciconfig  CREDITS       firmware     .gitattributes        init          kernel  MAINTAINERS
mm    .scmversion    tools
block .config        crypto        fs           .gitlab-ci-private.yml  ipc          lib     Makefile
net   scripts       usr
```

Consultez ce fichier :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ more .config
#
# Automatically generated file; DO NOT EDIT.
# Linux/x86 4.18.0 Kernel Configuration
#
#
# Compiler: gcc (GCC) 8.4.1 20200928 (Red Hat 8.4.1-1)
#
CONFIG_64BIT=y
CONFIG_X86_64=y
CONFIG_X86=y
CONFIG_INSTRUCTION_DECODER=y
CONFIG_OUTPUT_FORMAT="elf64-x86-64"
CONFIG_ARCH_DEFCONFIG="arch/x86/configs/x86_64_defconfig"
```

```
CONFIG_LOCKDEP_SUPPORT=y
CONFIG_STACKTRACE_SUPPORT=y
CONFIG_MMU=y
CONFIG_ARCH_MMAP_RND_BITS_MIN=28
CONFIG_ARCH_MMAP_RND_BITS_MAX=32
CONFIG_ARCH_MMAP_RND_COMPAT_BITS_MIN=8
CONFIG_ARCH_MMAP_RND_COMPAT_BITS_MAX=16
CONFIG_GENERIC_ISA_DMA=y
CONFIG_GENERIC_BUG=y
CONFIG_GENERIC_BUG_RELATIVE_POINTERS=y
CONFIG_GENERIC_HWEIGHT=y
CONFIG_ARCH_MAY_HAVE_PC_FDC=y
CONFIG_GENERIC_CALIBRATE_DELAY=y
CONFIG_ARCH_HAS_CPU_RELAX=y
CONFIG_ARCH_HAS_CACHE_LINE_SIZE=y
CONFIG_ARCH_HAS_FILTER_PGPROT=y
CONFIG_HAVE_SETUP_PER_CPU_AREA=y
CONFIG_NEED_PER_CPU_EMBED_FIRST_CHUNK=y
CONFIG_NEED_PER_CPU_PAGE_FIRST_CHUNK=y
CONFIG_ARCH_HIBERNATION_POSSIBLE=y
CONFIG_ARCH_SUSPEND_POSSIBLE=y
CONFIG_ARCH_WANT_HUGE_PMD_SHARE=y
CONFIG_ARCH_WANT_GENERAL_HUGETLB=y
CONFIG_ZONE_DMA32=y
CONFIG_AUDIT_ARCH=y
CONFIG_ARCH_SUPPORTS_OPTIMIZED_INLINING=y
CONFIG_ARCH_SUPPORTS_DEBUG_PAGEALLOC=y
CONFIG_HAVE_INTEL_TXT=y
CONFIG_X86_64_SMP=y
--More-- (0%)
```

## Le Fichier Makefile

Le fichier **Makefile** contient le nom du noyau et spécifie les informations suivantes :

- VERSION,
- PATCHLEVEL,
- SUBLEVEL,
- EXTRAVERSION.

Les trois premières informations sont gérées par **kernel.org** et Linus Torvalds en personne tandis que l'EXTRAVERSION est gérée par Red Hat :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ more Makefile
# SPDX-License-Identifier: GPL-2.0
VERSION = 4
PATCHLEVEL = 18
SUBLEVEL = 0
EXTRAVERSION =
NAME = Merciless Moray

#
# DRM backport version
#
RHEL_DRM_VERSION = 5
RHEL_DRM_PATCHLEVEL = 9
RHEL_DRM_SUBLEVEL = 14

# *DOCUMENTATION*
# To see a list of typical targets execute "make help"
# More info can be located in ./README
# Comments in this file are targeted only to the developer, do not
# expect to learn how to build the kernel reading this file.

# That's our default target when none is given on the command line
PHONY := _all
_all:
```

```
# o Do not use make's built-in rules and variables
#   (this increases performance and avoids hard-to-debug behaviour);
# o Look for make include files relative to root of kernel src
MAKEFLAGS += -rR --include-dir=$(CURDIR)

# Avoid funny character set dependencies
unexport LC_ALL
LC_COLLATE=C
LC_NUMERIC=C
export LC_COLLATE LC_NUMERIC

# Avoid interference with shell env settings
unexport GREP_OPTIONS

# Set RHEL variables
# Use this spot to avoid future merge conflicts
include Makefile.rhelver

# We are using a recursive build, so we need to do a little thinking
--Plus--(2%)
```



**Important** - La version 2.6 du noyau a vu le jour en **2003**. Les **SUBLEVEL** se suivaient régulièrement. Avec la version 2.6 du noyau, la valeur paire du **PATCHLEVEL** indiquait que le noyau était stable. Quand vous recompilez le noyau à partir des sources, vous devez modifier la valeur de l'EXTRAVERSION. Le passage à la version 3.0 fut décidé par Linus Torvalds à l'occasion des 20 ans du noyau Linux. Depuis l'arrivée de la version 3 du noyau, la signification de la valeur de PATCHLEVEL paire et impaire a été abandonnée.

## 2.4 - Paramétrage du noyau

Insérez la sortie de la commande **uname -i** sur la première ligne du fichier `.config` :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ uname -i
x86_64
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ vi .config
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ head .config
# x86_64
#
# Automatically generated file; DO NOT EDIT.
# Linux/x86 4.18.0 Kernel Configuration
#
#
# Compiler: gcc (GCC) 8.4.1 20200928 (Red Hat 8.4.1-1)
#
CONFIG_64BIT=y
```

Renommez le fichier `.config` en le plaçant dans le répertoire `~/rpmbuild/SOURCES/` :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ cp .config ~/rpmbuild/SOURCES/config-`uname -m`-generic
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ ls ~/rpmbuild/SOURCES
centos-ca-secureboot.der  cpupower.config          filter-x86_64.sh          kernel-
s390x.config              mod-extra.list           Module.kabi_s390x
centos-dup.x509           cpupower.service        generate_all_configs.sh   kernel-s390x-
debug.config              mod-internal.list        Module.kabi_x86_64
centos-kpatch.x509       debrand-rh-i686-cpu.patch generate_bls_conf.sh      kernel-s390x-
zfcpdump.config          mod-sign.sh              parallel_xz.sh
centos.pem                debrand-rh_taint.patch   kernel-aarch64.config     kernel-
x86_64.config             Module.kabi_aarch64      process_configs.sh
centossecureboot001.der  debrand-single-cpu.patch kernel-aarch64-debug.config kernel-x86_64-
debug.config              Module.kabi_dup_aarch64  x509.genkey
```

```
centossecureboot201.der  filter-aarch64.sh          kernel-abi-stablelists-4.18.0-305.tar.bz2
kvm_stat.logrotate      Module.kabi_dup_ppc64le
centossecurebootca2.der  filter-modules.sh          kernel-kabi-dw-4.18.0-305.tar.bz2
linux-4.18.0-305.7.1.el8_4.tar.xz  Module.kabi_dup_s390x
check-kabi               filter-ppc64le.sh          kernel-ppc64le.config          linux-kernel-
test.patch               Module.kabi_dup_x86_64
config-x86_64-generic    filter-s390x.sh            kernel-ppc64le-debug.config    mod-blacklist.sh
Module.kabi_ppc64le
```

Copiez le contenu du répertoire **configs** vers le répertoire **~/rpmbuild/SOURCES/** :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ cp configs/* ~/rpmbuild/SOURCES/
```

Editez la directive **buildid** dans le fichier **~/rpmbuild/SPECS/kernel.spec** :

```
[trainee@centos8 linux-4.18.0-305.7.1.el8.x86_64]$ cd ~/rpmbuild/SPECS
[trainee@centos8 SPECS]$ vi kernel.spec

[trainee@centos8 SPECS]$ head -n 50 kernel.spec
# We have to override the new %install behavior because, well... the kernel is special.
%global __spec_install_pre %{__build_pre}

# At the time of this writing (2019-03), RHEL8 packages use w2.xzdio
# compression for rpms (xz, level 2).
# Kernel has several large (hundreds of mbytes) rpms, they take ~5 mins
# to compress by single-threaded xz. Switch to threaded compression,
# and from level 2 to 3 to keep compressed sizes close to "w2" results.
#
# NB: if default compression in /usr/lib/rpm/redhat/macros ever changes,
# this one might need tweaking (e.g. if default changes to w3.xzdio,
# change below to w4T.xzdio):
%define _binary_payload w3T.xzdio
```

```
# For a kernel released for public testing, released_kernel should be 1.
# For internal testing builds during development, it should be 0.
%global released_kernel 1

%global distro_build 305

# Sign the x86_64 kernel for secure boot authentication
%ifarch x86_64 aarch64
%global signkernel 1
%else
%global signkernel 0
%endif

# Sign modules on all arches
%global signmodules 1

# Compress modules only for architectures that build modules
%ifarch noarch
%global zipmodules 0
%else
%global zipmodules 1
%endif

%if %{zipmodules}
%global zipsed -e 's/\.ko$/\.ko.xz/'
%endif

%define buildid .i2tch

%define rpmversion 4.18.0
%define pkgrelease 305.7.1.el8_4

# allow pkg_release to have configurable %{?dist} tag
%define specrelease 305.7.1%{?dist}
```

```
%define pkg_release %{specrelease}%{?buildid}
```

## 2.5 - Compiler le Noyau

La compilation du noyau peut prendre beaucoup de temps (~5 heures). La commande utilisée est la suivante :

```
[trainee@centos7 SPECS]$ rpmbuild -bb --target=`uname -m` kernel.spec 2> build-err.log | tee build-out.log &
```



**Important** - La compilation peut prendre des heures. Arrêtez donc le processus avec les touches ^C. Arrêtez ensuite votre VM. Demandez à votre formateur de démarrer la VM contenant le noyau déjà compilé.

A l'issue du processus, les RPMs se trouvent dans le répertoire **/home/trainee/rpmbuild/RPMS/x86\_64/** :

```
...
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-headers-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-cross-headers-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debuginfo-common-x86_64-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/perf-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/perf-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/python3-perf-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/python3-perf-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-tools-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-tools-libs-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-tools-libs-devel-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-tools-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/bpftool-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/bpftool-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-selftests-internal-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
```

```
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debug-core-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debug-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debug-devel-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debug-modules-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debug-modules-extra-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debug-modules-internal-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debug-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-core-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-devel-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-modules-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-modules-extra-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-modules-internal-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Wrote: /home/trainee/rpmbuild/RPMS/x86_64/kernel-ipa clones-internal-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
Executing(%clean): /bin/sh -e /var/tmp/rpm-tmp.rk0gfs
```

```
[1]+  Done                rpmbuild -bb --target=`uname -m` kernel.spec 2> build-err.log | tee build-out.log
```

```
[trainee@centos8 SPECS]$ cd ../RPMS
[trainee@centos8 RPMS]$ ls
x86_64
[trainee@centos8 RPMS]$ cd x86_64/
[trainee@centos8 x86_64]$ ls
bpftool-4.18.0-305.7.1.el8.i2tch.x86_64.rpm          kernel-debuginfo-common-
x86_64-4.18.0-305.7.1.el8.i2tch.x86_64.rpm          kernel-selftests-internal-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
bpftool-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm  kernel-debug-
modules-4.18.0-305.7.1.el8.i2tch.x86_64.rpm          kernel-tools-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-4.18.0-305.7.1.el8.i2tch.x86_64.rpm           kernel-debug-modules-
extra-4.18.0-305.7.1.el8.i2tch.x86_64.rpm           kernel-tools-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-core-4.18.0-305.7.1.el8.i2tch.x86_64.rpm      kernel-debug-modules-
internal-4.18.0-305.7.1.el8.i2tch.x86_64.rpm        kernel-tools-libs-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-cross-headers-4.18.0-305.7.1.el8.i2tch.x86_64.rpm  kernel-devel-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-tools-libs-devel-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-debug-4.18.0-305.7.1.el8.i2tch.x86_64.rpm      kernel-headers-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
```

```

perf-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-debug-core-4.18.0-305.7.1.el8.i2tch.x86_64.rpm      kernel-ipaclones-
internal-4.18.0-305.7.1.el8.i2tch.x86_64.rpm              perf-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-debug-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm  kernel-modules-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
python3-perf-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-debug-devel-4.18.0-305.7.1.el8.i2tch.x86_64.rpm      kernel-modules-
extra-4.18.0-305.7.1.el8.i2tch.x86_64.rpm                  python3-perf-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm
kernel-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64.rpm        kernel-modules-
internal-4.18.0-305.7.1.el8.i2tch.x86_64.rpm

```

Notez que la génération du nouveau noyau peut consommer jusqu'à 21 Go d'espace disque :

```

[trainee@centos8 x86_64]$ df -h
Filesystem      Size  Used Avail Use% Mounted on
devtmpfs        1.8G   0 1.8G   0% /dev
tmpfs           1.9G   0 1.9G   0% /dev/shm
tmpfs           1.9G  9.4M 1.9G   1% /run
tmpfs           1.9G   0 1.9G   0% /sys/fs/cgroup
/dev/mapper/cl_centos8-root 28G  5.5G  23G  20% /
/dev/sda1       976M  289M  620M  32% /boot
tmpfs           374M   24K  374M   1% /run/user/1000
tmpfs           374M  1.2M  373M   1% /run/user/42
/dev/sdc1       63G   21G   39G  35% /home

```

## 2.6 - Installer le Nouveau Noyau

Installez maintenant les paquets **kernel\***. L'installation du noyau peut prendre beaucoup de temps (~2 heures). La commande utilisée est la suivante :

```

[root@centos8 x86_64]# dnf localinstall kernel-*.rpm
Last metadata expiration check: 2:25:32 ago on Tue 20 Jul 2021 08:37:00 EDT.
Dependencies resolved.
=====

```

Package Repository	Size	Architecture	Version
Installing:			
kernel		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	5.9 M
kernel-core		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	36 M
kernel-cross-headers		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	11 M
kernel-debug		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	5.9 M
kernel-debug-core		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	63 M
kernel-debug-debuginfo		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	683 M
kernel-debug-devel		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	19 M
kernel-debug-modules		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	54 M
kernel-debug-modules-extra		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	7.2 M
kernel-debug-modules-internal		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	6.3 M
kernel-debuginfo		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	570 M
kernel-debuginfo-common-x86_64		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	75 M
kernel-devel		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	18 M
kernel-ipa clones-internal		x86_64	
4.18.0-305.7.1.el8.i2tch		@commandline	20 M

```
kernel-modules                x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      28 M
kernel-modules-extra          x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      6.5 M
kernel-modules-internal       x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      6.1 M
kernel-selftests-internal     x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      19 M
kernel-tools-debuginfo        x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      6.2 M
kernel-tools-libs-devel       x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      5.9 M
Downgrading:
kernel-headers                x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      7.1 M
kernel-tools                  x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      6.1 M
kernel-tools-libs             x86_64
4.18.0-305.7.1.el8.i2tch      @commandline      5.9 M
```

#### Transaction Summary

```
=====
=====
Install    20 Packages
Downgrade   3 Packages
```

```
Total size: 1.6 G
Is this ok [y/N]: y
```

A l'issu de l'installation, re-démarrez la VM :

```
[root@centos7 ~]# reboot
```

Connectez-vous en tant que trainee et devenez root. Listez ensuite les noyaux installés :

```
[root@centos8 ~]# rpm -qa | grep kernel
kernel-modules-4.18.0-305.3.1.el8.x86_64
kernel-tools-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-headers-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-debug-core-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-modules-internal-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-modules-4.18.0-305.7.1.el8_4.x86_64
kernel-debug-modules-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-devel-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-tools-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-tools-libs-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-debug-modules-internal-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-cross-headers-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-core-4.18.0-305.7.1.el8_4.x86_64
kernel-devel-4.18.0-305.7.1.el8_4.x86_64
kernel-debuginfo-common-x86_64-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-debug-modules-extra-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-debug-devel-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-tools-libs-devel-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-modules-extra-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-4.18.0-305.7.1.el8_4.x86_64
kernel-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-core-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-selftests-internal-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-debug-debuginfo-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-debug-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-4.18.0-305.3.1.el8.x86_64
kernel-core-4.18.0-305.3.1.el8.x86_64
kernel-modules-4.18.0-305.7.1.el8.i2tch.x86_64
kernel-ipa clones-internal-4.18.0-305.7.1.el8.i2tch.x86_64
```

Constatez l'entrée **saved-entry** du fichier **/boot/grub2/grubenv** :

```
[root@centos8 ~]# grep i2tch /boot/grub2/grubenv  
saved_entry=95bd69e34a7444a7b58cb74fbfb86df2-4.18.0-305.7.1.el8.i2tch.x86_64
```

Dernièrement, vérifiez l'utilisation du nouveau noyau :

```
[root@centos8 ~]# uname -r  
4.18.0-305.7.1.el8.i2tch.x86_64
```

## LAB #3 - Compilation et installation du noyau sous Debian 11

Commencez par installer les paquets nécessaires :

```
root@debian11:~# apt-get update  
Hit:1 http://deb.debian.org/debian bullseye InRelease  
Get:2 http://deb.debian.org/debian bullseye-updates InRelease [39.4 kB]  
Get:3 http://security.debian.org/debian-security bullseye-security InRelease [44.1 kB]  
Fetched 83.5 kB in 1s (158 kB/s)  
Reading package lists... Done  
  
root@debian11:~# apt-get -y install build-essential linux-source bc kmod cpio flex libncurses5-dev libelf-dev  
libssl-dev dwarves debconf-utils dpkg-dev debhelper ncurses-dev
```

### 1.1 - Déplacer /home

Créez une seule partition sur **/dev/sdb** :

```
root@debian11:~# fdisk /dev/sdb  
  
Welcome to fdisk (util-linux 2.36.1).  
Changes will remain in memory only, until you decide to write them.
```

Be careful before using the write command.

Device does not contain a recognized partition table.  
Created a new DOS disklabel with disk identifier 0xa10c368d.

Command (m for help): n

Partition type

- p primary (0 primary, 0 extended, 4 free)
- e extended (container for logical partitions)

Select (default p):

Using default response p.

Partition number (1-4, default 1):

First sector (2048-134217727, default 2048):

Last sector, +/-sectors or +/-size{K,M,G,T,P} (2048-134217727, default 134217727):

Created a new partition 1 of type 'Linux' and of size 64 GiB.

Command (m for help): w

The partition table has been altered.

Calling ioctl() to re-read partition table.

Syncing disks.

Créez maintenant un système de fichiers ext4 sur **/dev/sdb1** :

```
root@debian11:~# mkfs.ext4 /dev/sdb1
```

```
mke2fs 1.46.2 (28-Feb-2021)
```

```
Discarding device blocks: done
```

```
Creating filesystem with 16776960 4k blocks and 4194304 inodes
```

```
Filesystem UUID: 24f1821e-1d5b-4256-8ee3-c9ee6b382ddc
```

```
Superblock backups stored on blocks:
```

```
    32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,  
    4096000, 7962624, 11239424
```

```
Allocating group tables: done
Writing inode tables: done
Creating journal (65536 blocks): done
Writing superblocks and filesystem accounting information: done
```

Editez le fichier **/etc/ssh/sshd\_config** et modifiez la directive **PermitRootLogin** :

```
root@debian11:~# vi /etc/ssh/sshd_config
root@debian11:~# cat /etc/ssh/sshd_config
#      $OpenBSD: sshd_config,v 1.103 2018/04/09 20:41:22 tj Exp $

# This is the sshd server system-wide configuration file.  See
# sshd_config(5) for more information.

# This sshd was compiled with PATH=/usr/bin:/bin:/usr/sbin:/sbin

# The strategy used for options in the default sshd_config shipped with
# OpenSSH is to specify options with their default value where
# possible, but leave them commented.  Uncommented options override the
# default value.

Include /etc/ssh/sshd_config.d/*.conf

#Port 22
#AddressFamily any
#ListenAddress 0.0.0.0
#ListenAddress ::

#HostKey /etc/ssh/ssh_host_rsa_key
#HostKey /etc/ssh/ssh_host_ecdsa_key
#HostKey /etc/ssh/ssh_host_ed25519_key

# Ciphers and keying
#RekeyLimit default none
```

```
# Logging
#SyslogFacility AUTH
#LogLevel INFO

# Authentication:

#LoginGraceTime 2m
PermitRootLogin yes
#StrictModes yes
#MaxAuthTries 6
#MaxSessions 10

...
```

Re-démarrez le serveur ssh :

```
root@debian11:~# systemctl restart sshd
root@debian11:~# systemctl status sshd
● ssh.service - OpenBSD Secure Shell server
   Loaded: loaded (/lib/systemd/system/ssh.service; enabled; vendor preset: enabled)
   Active: active (running) since Sun 2022-05-01 15:35:50 CEST; 6s ago
     Docs: man:sshd(8)
           man:sshd_config(5)
  Process: 2793 ExecStartPre=/usr/sbin/sshd -t (code=exited, status=0/SUCCESS)
 Main PID: 2794 (sshd)
    Tasks: 1 (limit: 4656)
   Memory: 1.1M
      CPU: 25ms
   CGroup: /system.slice/ssh.service
           └─2794 sshd: /usr/sbin/sshd -D [listener] 0 of 10-100 startups

May 01 15:35:50 debian11 systemd[1]: Starting OpenBSD Secure Shell server...
May 01 15:35:50 debian11 sshd[2794]: Server listening on 0.0.0.0 port 22.
May 01 15:35:50 debian11 sshd[2794]: Server listening on :: port 22.
```

```
May 01 15:35:50 debian11 systemd[1]: Started OpenBSD Secure Shell server.
```



**A Faire** - Déconnectez-vous en ssh. Connectez-vous directement en tant que root en ssh.

Montez **/dev/sdb1** sur /mnt :

```
root@debian11:~# mount /dev/sdb1 /mnt
```

Copiez le contenu de /home vers /mnt :

```
root@debian11:~# cp -a /home/* /mnt
```

Démontez /dev/sdb1 :

```
root@debian11:~# umount /mnt
```

Identifiez l'UUID de /dev/sdb1 :

```
root@debian11:~# ls -l /dev/disk/by-uuid/ | grep sdb1
lrwxrwxrwx 1 root root 10 May  1 15:31 24f1821e-1d5b-4256-8ee3-c9ee6b382ddc -> ../../sdb1
```

Editez le fichier **/etc/fstab** en ajoutant la ligne pour le montage de /home :

```
root@debian11:~# vi /etc/fstab
root@debian11:~# cat /etc/fstab
# /etc/fstab: static file system information.
#
# Use 'blkid' to print the universally unique identifier for a
# device; this may be used with UUID= as a more robust way to name devices
# that works even if disks are added and removed. See fstab(5).
#
```

```
# systemd generates mount units based on this file, see systemd.mount(5).
# Please run 'systemctl daemon-reload' after making changes here.
#
# <file system> <mount point> <type> <options> <dump> <pass>
# / was on /dev/sda1 during installation
UUID=9887a74f-a680-4bde-8f04-db5ae9ea186e / ext4 errors=remount-ro 0 1
UUID=24f1821e-1d5b-4256-8ee3-c9ee6b382ddc /home ext4 defaults 0 0
# swap was on /dev/sda5 during installation
UUID=1f9439f5-4b19-49b1-b292-60c2c674cee9 none swap sw 0 0
/dev/sr0 /media/cdrom0 udf,iso9660 user,noauto 0 0
```

Créez le point de montage /home :

```
root@debian11:~# rm -rf /home
root@debian11:~# mkdir /home
```

Montez /dev/sdb1 :

```
root@debian11:~# mount -a

root@debian11:~# mount
sysfs on /sys type sysfs (rw,nosuid,nodev,noexec,relatime)
proc on /proc type proc (rw,nosuid,nodev,noexec,relatime)
udev on /dev type devtmpfs (rw,nosuid,relatime,size=1986968k,nr_inodes=496742,mode=755)
devpts on /dev/pts type devpts (rw,nosuid,noexec,relatime,gid=5,mode=620,ptmxmode=000)
tmpfs on /run type tmpfs (rw,nosuid,nodev,noexec,relatime,size=402560k,mode=755)
/dev/sda1 on / type ext4 (rw,relatime,errors=remount-ro)
securityfs on /sys/kernel/security type securityfs (rw,nosuid,nodev,noexec,relatime)
tmpfs on /dev/shm type tmpfs (rw,nosuid,nodev)
tmpfs on /run/lock type tmpfs (rw,nosuid,nodev,noexec,relatime,size=5120k)
cgroup2 on /sys/fs/cgroup type cgroup2 (rw,nosuid,nodev,noexec,relatime,nsdelegate,memory_recursiveprot)
pstore on /sys/fs/pstore type pstore (rw,nosuid,nodev,noexec,relatime)
none on /sys/fs/bpf type bpf (rw,nosuid,nodev,noexec,relatime,mode=700)
systemd-1 on /proc/sys/fs/binfmt_misc type autofs
```

```
(rw,relatime,fd=29,pgrp=1,timeout=0,minproto=5,maxproto=5,direct,pipe_ino=11732)
mqueue on /dev/mqueue type mqueue (rw,nosuid,nodev,noexec,relatime)
debugfs on /sys/kernel/debug type debugfs (rw,nosuid,nodev,noexec,relatime)
hugetlbfs on /dev/hugepages type hugetlbfs (rw,relatime,pagesize=2M)
tracefs on /sys/kernel/tracing type tracefs (rw,nosuid,nodev,noexec,relatime)
configfs on /sys/kernel/config type configfs (rw,nosuid,nodev,noexec,relatime)
fusectl on /sys/fs/fuse/connections type fusectl (rw,nosuid,nodev,noexec,relatime)
tmpfs on /run/user/0 type tmpfs (rw,nosuid,nodev,relatime,size=402556k,nr_inodes=100639,mode=700)
/dev/sdb1 on /home type ext4 (rw,relatime)
```

Notez la taille de /home :

```
root@debian11:~# df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            1.9G   0    1.9G   0% /dev
tmpfs           394M  892K  393M   1% /run
/dev/sda1       31G   4.1G   25G  14% /
tmpfs           2.0G   0    2.0G   0% /dev/shm
tmpfs           5.0M   0    5.0M   0% /run/lock
tmpfs           394M   36K  394M   1% /run/user/0
/dev/sdb1       63G   1.4M   60G   1% /home
```



**A Faire** - Fermez la session de root et connectez-vous en tant que trainee en ssh.

## 1.2 - Télécharger le Code Source du Noyau

Le code source est disponible sur le site [www.kernel.org](https://www.kernel.org) :

```
trainee@debian11:~$ wget https://www.kernel.org/pub/linux/kernel/v5.x/linux-5.11.1.tar.gz
--2022-05-01 15:46:58-- https://www.kernel.org/pub/linux/kernel/v5.x/linux-5.11.1.tar.gz
```

```
Resolving www.kernel.org (www.kernel.org)... 145.40.68.75, 2604:1380:4601:e00::1
Connecting to www.kernel.org (www.kernel.org)|145.40.68.75|:443... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: https://mirrors.edge.kernel.org/pub/linux/kernel/v5.x/linux-5.11.1.tar.gz [following]
--2022-05-01 15:46:58-- https://mirrors.edge.kernel.org/pub/linux/kernel/v5.x/linux-5.11.1.tar.gz
Resolving mirrors.edge.kernel.org (mirrors.edge.kernel.org)... 147.75.101.1, 2604:1380:2001:3900::1
Connecting to mirrors.edge.kernel.org (mirrors.edge.kernel.org)|147.75.101.1|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 186370882 (178M) [application/x-gzip]
Saving to: 'linux-5.11.1.tar.gz'

linux-5.11.1.tar.gz
100%[=====
=====>] 177.74M  83.4MB/s   in 2.1s

2022-05-01 15:47:01 (83.4 MB/s) - 'linux-5.11.1.tar.gz' saved [186370882/186370882]
```

Désarchivez le tar.xz que vous avez téléchargé :

```
trainee@debian8:~$ tar xf linux-5.11.1.tar.gz
```

Notez que l'occupation disque du code source du noyau linux-5.11.1 est de 1.2 Go :

```
trainee@debian11:~$ du -hs ./linux-5.11.1
1.2G   ./linux-5.11.1
```

### 1.3 - Configurer le Noyau

Le fichier **Makefile** contient le nom du noyau et spécifie les informations suivantes :

- VERSION,
- PATCHLEVEL,
- SUBLEVEL,

- EXTRAVERSION.

Les trois premières informations sont gérées par **kernel.org** et Linus Torvalds en personne tandis que l'EXTRAVERSION est gérée par Debian :

```
trainee@debian11:~$ cat ./linux-5.11.1/Makefile | head
# SPDX-License-Identifier: GPL-2.0
VERSION = 5
PATCHLEVEL = 11
SUBLEVEL = 1
EXTRAVERSION =
NAME = [ Valentine's Day Edition ]

# *DOCUMENTATION*
# To see a list of typical targets execute "make help"
# More info can be located in ./README
```



**Important** - La version 2.6 du noyau a vu le jour en **2003**. Les **SUBLEVEL** se suivaient régulièrement. Avec la version 2.6 du noyau, la valeur paire du **PATCHLEVEL** indiquait que le noyau était stable. Quand vous recompilez le noyau à partir des sources, vous devez modifier la valeur de l'EXTRAVERSION. Le passage à la version 3.0 fut décidé par Linus Torvalds à l'occasion des 20 ans du noyau Linux.

Utilisez maintenant la commande **make defconfig** pour créer le fichier de configuration .config :

```
trainee@debian11:~$ su -
Password: fenestros
root@debian11:~# cd /home/trainee/linux-5.11.1/
root@debian11:/home/trainee/linux-5.11.1# make defconfig
HOSTCC  scripts/basic/fixdep
HOSTCC  scripts/kconfig/conf.o
HOSTCC  scripts/kconfig/confdata.o
HOSTCC  scripts/kconfig/expr.o
LEX     scripts/kconfig/lexer.lex.c
```

```
YACC    scripts/kconfig/parser.tab.[ch]
HOSTCC  scripts/kconfig/lexer.lex.o
HOSTCC  scripts/kconfig/parser.tab.o
HOSTCC  scripts/kconfig/preprocess.o
HOSTCC  scripts/kconfig/symbol.o
HOSTCC  scripts/kconfig/util.o
HOSTLD  scripts/kconfig/conf
*** Default configuration is based on 'x86_64_defconfig'
#
# configuration written to .config
#
```

Ce fichier est configuré par une des trois commandes suivantes :

- make config
- make menuconfig
- make xconfig

Dans ce fichier, vous pouvez constater la présence de lignes correspondantes à des fonctionnalités suivies par une lettre ou une valeur. Dans le cas d'une lettre, la signification est la suivante :

- **y**
  - la fonctionnalité est incluse dans le noyau monolithique ou dans le cas d'une dépendance d'un module, dans le module concerné,
- **m**
  - la fonctionnalité est incluse en tant que module,
- **n**
  - la fonctionnalité n'est pas incluse. Cette option est rarement visible car dans bien les cas, la fonctionnalité est simplement commentée dans le fichier lui-même.

```
root@debian11:/home/trainee/linux-5.11.1# more .config
#
# Automatically generated file; DO NOT EDIT.
# Linux/x86 5.11.1 Kernel Configuration
#
CONFIG_CC_VERSION_TEXT="gcc (Debian 10.2.1-6) 10.2.1 20210110"
```

```
CONFIG_CC_IS_GCC=y
CONFIG_GCC_VERSION=100201
CONFIG_LD_VERSION=235020000
CONFIG_CLANG_VERSION=0
CONFIG_LLD_VERSION=0
CONFIG_CC_CAN_LINK=y
CONFIG_CC_CAN_LINK_STATIC=y
CONFIG_CC_HAS_ASM_GOTO=y
CONFIG_CC_HAS_ASM_INLINE=y
CONFIG_IRQ_WORK=y
CONFIG_BUILDTIME_TABLE_SORT=y
CONFIG_THREAD_INFO_IN_TASK=y

#
# General setup
#
CONFIG_INIT_ENV_ARG_LIMIT=32
# CONFIG_COMPILE_TEST is not set
CONFIG_LOCALVERSION=""
# CONFIG_LOCALVERSION_AUTO is not set
CONFIG_BUILD_SALT=""
CONFIG_HAVE_KERNEL_GZIP=y
CONFIG_HAVE_KERNEL_BZIP2=y
CONFIG_HAVE_KERNEL_LZMA=y
CONFIG_HAVE_KERNEL_XZ=y
CONFIG_HAVE_KERNEL_LZ0=y
CONFIG_HAVE_KERNEL_LZ4=y
CONFIG_HAVE_KERNEL_ZSTD=y
CONFIG_KERNEL_GZIP=y
# CONFIG_KERNEL_BZIP2 is not set
# CONFIG_KERNEL_LZMA is not set
# CONFIG_KERNEL_XZ is not set
# CONFIG_KERNEL_LZ0 is not set
# CONFIG_KERNEL_LZ4 is not set
```

```
# CONFIG_KERNEL_ZSTD is not set
CONFIG_DEFAULT_INIT=""
CONFIG_DEFAULT_HOSTNAME="(none)"
CONFIG_SWAP=y
CONFIG_SYSVIPC=y
CONFIG_SYSVIPC_SYSCTL=y
CONFIG_POSIX_MQUEUE=y
CONFIG_POSIX_MQUEUE_SYSCTL=y
# CONFIG_WATCH_QUEUE is not set
CONFIG_CROSS_MEMORY_ATTACH=y
CONFIG_USELIB=y
CONFIG_AUDIT=y
CONFIG_HAVE_ARCH_AUDITSYSCALL=y
CONFIG_AUDITSYSCALL=y

#
# IRQ subsystem
#
CONFIG_GENERIC_IRQ_PROBE=y
--More-- (1%)
[q]
```

## 1.4 - Compiler le Noyau

La compilation du noyau peut prendre beaucoup de temps. La commande utilisée est la suivante :

```
root@debian11:/home/trainee/linux-5.11.1# make deb-pkg clean
...
dpkg-buildpackage: info: full upload (original source is included)
CLEAN arch/x86/entry/vdso
CLEAN arch/x86/kernel/cpu
CLEAN arch/x86/kernel
CLEAN arch/x86/realmode/rm
```

```
CLEAN arch/x86/lib
CLEAN certs
CLEAN drivers/firmware/efi/libstub
CLEAN drivers/scsi
CLEAN drivers/tty/vt
CLEAN drivers/video/logo
CLEAN lib
CLEAN net/wireless
CLEAN security/selinux
CLEAN usr/include
CLEAN usr
CLEAN arch/x86/boot/compressed
CLEAN arch/x86/boot
CLEAN arch/x86/tools
CLEAN vmlinux.symvers modules.builtin modules.builtin.modinfo
```

A l'issu du processus, les paquets du nouveau noyau se trouvent dans le répertoire **/home/trainee** :

```
root@debian11:/home/trainee/linux-5.11.1# cd ..
root@debian11:/home/trainee# ls
Desktop      linux-5.11.1                linux-5.11.1_5.11.1-1.diff.gz  linux-5.11.1.tar.gz
linux-libc-dev_5.11.1-1_amd64.deb  Public
Documents   linux-5.11.1_5.11.1-1_amd64.buildinfo  linux-5.11.1_5.11.1-1.dsc      linux-
headers-5.11.1_5.11.1-1_amd64.deb  Music                        Templates
Downloads   linux-5.11.1_5.11.1-1_amd64.changes    linux-5.11.1_5.11.1.orig.tar.gz  linux-
image-5.11.1_5.11.1-1_amd64.deb     Pictures                      Videos
```

## 1.5 - Installer le Noyau

Installez maintenant les paquets **deb** :

```
root@debian11:/home/trainee# dpkg -i /home/trainee/linux*.deb
```

Constatez la création d'un nouveau grub.cfg :

```
root@debian11:/home/trainee# grep 5.11.1 /boot/grub/grub.cfg
    echo    'Loading Linux 5.11.1 ...'
    linux   /boot/vmlinuz-5.11.1 root=UUID=9887a74f-a680-4bde-8f04-db5ae9ea186e ro quiet
    initrd  /boot/initrd.img-5.11.1
    menuentry 'Debian GNU/Linux, with Linux 5.11.1' --class debian --class gnu-linux --class gnu --class os
$menuentry_id_option 'gnulinux-5.11.1-advanced-9887a74f-a680-4bde-8f04-db5ae9ea186e' {
    echo    'Loading Linux 5.11.1 ...'
    linux   /boot/vmlinuz-5.11.1 root=UUID=9887a74f-a680-4bde-8f04-db5ae9ea186e ro quiet
    initrd  /boot/initrd.img-5.11.1
    menuentry 'Debian GNU/Linux, with Linux 5.11.1 (recovery mode)' --class debian --class gnu-linux --class
gnu --class os $menuentry_id_option 'gnulinux-5.11.1-recovery-9887a74f-a680-4bde-8f04-db5ae9ea186e' {
    echo    'Loading Linux 5.11.1 ...'
    linux   /boot/vmlinuz-5.11.1 root=UUID=9887a74f-a680-4bde-8f04-db5ae9ea186e ro single
    initrd  /boot/initrd.img-5.11.1
```

## 1.6 - Désinstaller un Noyau

Lister les noyaux installés :

```
root@debian11:/home/trainee# dpkg -l | grep -i "linux-image*" | awk '{print $2}'
linux-image-5.10.0-13-amd64
linux-image-5.11.1
linux-image-amd64
```

Le noyau se désinstalle comme tout autre paquet :

```
root@debian11:/home/trainee# apt-get -y purge "linux-image-5.11.1"
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
```

```
The following packages will be REMOVED:
 linux-image-5.11.1*
0 upgraded, 0 newly installed, 1 to remove and 0 not upgraded.
After this operation, 15.1 MB disk space will be freed.
(Reading database ... 118012 files and directories currently installed.)
Removing linux-image-5.11.1 (5.11.1-1) ...
update-initramfs: Deleting /boot/initrd.img-5.11.1
Generating grub configuration file ...
Found background image: /usr/share/images/desktop-base/desktop-grub.png
Found linux image: /boot/vmlinuz-5.10.0-13-amd64
Found initrd image: /boot/initrd.img-5.10.0-13-amd64
done
(Reading database ... 117967 files and directories currently installed.)
Purging configuration files for linux-image-5.11.1 (5.11.1-1) ...
```

Vérifiez que le fichier grub.cfg a été modifié :

```
root@debian11:/home/trainee# grep 5.11.1 /boot/grub/grub.cfg
root@debian11:/home/trainee#
```

Dernièrement, listez les noyaux disponibles :

```
root@debian11:/home/trainee# dpkg -l | grep -i "linux-image*" | awk '{print $2}'
linux-image-5.10.0-13-amd64
linux-image-amd64
```

## LAB #4 - Mise à Jour du Noyau avec le Gestionnaire des Paquets

Afin d'obtenir la **dernière version du noyau pré-compilée** par Debian, il convient d'ajouter les dépôts **unstable** :

```
root@debian11:/home/trainee# echo "deb http://deb.debian.org/debian unstable main contrib non-free" | sudo tee -a
/etc/apt/sources.list
```

```
deb http://deb.debian.org/debian unstable main contrib non-free
root@debian11:/home/trainee# echo "deb-src http://deb.debian.org/debian unstable main contrib non-free" | sudo
tee -a /etc/apt/sources.list
deb-src http://deb.debian.org/debian unstable main contrib non-free
```

Afin de ne faire que des mises à jour du **noyau** à partir de ce dépôt, créez le fichier **/etc/apt/preferences** :

```
root@debian11:/home/trainee# vi /etc/apt/preferences
root@debian11:/home/trainee# cat /etc/apt/preferences
Package: *
Pin: release a=bullseye
Pin-Priority: 500

Package: linux-image-amd64
Pin: release a=unstable
Pin-Priority: 1000

Package: *
Pin: release a=unstable
Pin-Priority: 100
```

Mettez à jour apt :

```
root@debian11:/home/trainee# apt update
Hit:1 http://security.debian.org/debian-security bullseye-security InRelease
Hit:2 http://deb.debian.org/debian bullseye InRelease
Get:3 http://deb.debian.org/debian bullseye-updates InRelease [39.4 kB]
Get:4 http://deb.debian.org/debian unstable InRelease [165 kB]
Get:5 http://deb.debian.org/debian unstable/contrib Sources [57.6 kB]
Get:6 http://deb.debian.org/debian unstable/main Sources [9,700 kB]
Get:7 http://deb.debian.org/debian unstable/non-free Sources [89.6 kB]
Get:8 http://deb.debian.org/debian unstable/main amd64 Packages [9,154 kB]
Get:9 http://deb.debian.org/debian unstable/main Translation-en [6,780 kB]
Get:10 http://deb.debian.org/debian unstable/contrib amd64 Packages [65.4 kB]
```

```
Get:11 http://deb.debian.org/debian unstable/contrib Translation-en [55.9 kB]
Get:12 http://deb.debian.org/debian unstable/non-free amd64 Packages [112 kB]
Get:13 http://deb.debian.org/debian unstable/non-free Translation-en [103 kB]
Fetched 26.3 MB in 5s (4,955 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
2 packages can be upgraded. Run 'apt list --upgradable' to see them.
```

Installez ensuite les mises-à-jour du noyau :

```
root@debian11:/home/trainee# apt -y upgrade
```

Re-démarrez votre VM :

```
root@debian11:/home/trainee# reboot
```

Connectez-vous de nouveau à la VM et contrôlez la version du noyau :

```
trainee@debian11:~$ uname -a
Linux debian11 5.17.0-1-amd64 #1 SMP PREEMPT Debian 5.17.3-1 (2022-04-18) x86_64 GNU/Linux
```

Déconnectez-vous et re-connectez-vous directement en tant que root.